THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

SOUTHERN RESEARCH INSTITUTE

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**EMISSION CONTAINMENT AND UTILIZATION SYSTEM**
APPLICATION:	**SECONDARY SEALING SYSTEM FOR RECIPROCATING COMPRESSOR ROD SEALS**
TECHNOLOGY NAME:	**SEAL ASSIST SYSTEM**
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The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups which consist of buyers, vendor organizations and permitters, and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Greenhouse Gas (GHG) Technology Verification Center (the Center), one of 12 technology areas under ETV, is operated by Southern Research Institute, in cooperation with EPA's National Risk Management Research Laboratory. The Center has recently evaluated the performance of the Seal Assist System. This verification statement provides a summary of the test results for the A&A Environmental Seals, Inc. Seal Assist System (SAS).

TECHNOLOGY DESCRIPTION

The Seal Assist System (SAS) is a secondary emission containment device designed for natural gas compressor stations to prevent compressor rod packing leaks from escaping into the atmosphere. The SAS allows existing rod packing leaks to continue, but the leaking gas is contained within a secondary containment gland. The contained gas is then collected, recompressed, and routed into the compressor engine fuel line for use.

The SAS consists of four primary components: the Emission Containment Gland (ECG), the Jets, the Recycle stream, and an Eductor/Compressor system which repressurizes the collected gas. The ECG is a secondary seal gland that is attached to an existing primary rod seal. Its primary function is to isolate rod emissions from entering the atmosphere by maintaining a slightly negative operating pressure. The ECG also includes a floating face seal, called the tertiary seal. The primary role of the tertiary seal is to prevent air from entering the fuel line.

The gas isolated in the ECG is brought into the SAS piping system by a series of jets. The jets contain a specially designed nozzle system that creates a near-sonic velocity jet stream. This induces gas flow from the ECG, and transports the collected gas into the low-pressure side of the jets, where it mixes with the motive gas. A small portion of the jet discharge stream is recirculated to the ECG. The recycle system provides a continuous supply of gas at slightly positive pressure to move the captured emissions from the ECG to the jets.

The gas exiting the Jet discharge stream is repressurized and transported to the engine fuel header by an Eductor/Compressor. The Eductor/Compressor unit is designed to boost clean, dry methane from a 2-4 psig suction pressure to a 90 psig discharge pressure. It requires a motive gas flow (350 scfm natural gas at 550 psig) to recompress the captured gas and inject it into the engine fuel header system. The motive gas is supplied by the station's main transmission pipeline.

The captured methane which is burned as engine fuel reduces greenhouse gas emissions in two ways. First, the gas which would have leaked to the atmosphere but is now used as fuel, replaces an equivalent amount of gas that would have otherwise been extracted from well-head production facilities and transported to the gas transmission stations. Second, the carbon dioxide (CO_2) emissions which result when the methane is burned as fuel have a significantly lower global warming potential than the raw methane that would have otherwise leaked to the atmosphere. These benefits are obtained with no net increase in CO_2 emissions.

VERIFICATION DESCRIPTION

The SAS was verified at a natural gas compressor station operated by Transwestern Pipeline Company - Enron Gas Pipeline Group. Three ECG glands were installed on three compressor rods. This verification statement summarizes Phase I test results, which consist of initial installation data and measurements collected between March 10 and 31, 1999. The specific verification goals associated with the Phase I testing efforts were to: Verify SAS leak tightness, gas recovery, and methane emission reduction performance; Document SAS installation and operating requirements; and Estimate SAS capital and installation costs. Conclusions presented in the Verification Statement are based on direct measurements, equipment logs and cost data submitted by installation contractors, and interviews with site operators.

The SAS will be tested continuously for an additional 4 months. A Phase II report containing longer-term technical and economic performance results will be issued at the conclusion of the test. The scope of the Phase II test will be to evaluate longer-term gas recovery performance and determine the technology's payback period. Details of the verification test design, measurement test procedures, and quality assurance/quality control (QA/QC) procedures can be found in the following Test Report: *Test/QA Plan for A&A Environmental Seals' Seal Assist System (SAS)*, *December 18, 1998*. Details of the Phase I verification test results may be found in the report titled *Environmental Technology Verification Report, A&A Environmental Seals, Inc., Seal Assist System, Phase I.*

Both reports have been reviewed extensively by A&A ESI personnel, Transwestern Pipeline Company personnel, selected members of the Center's Oil and Gas Industry Stakeholder Group, and the EPA QA Team. Copies of the reports may be downloaded from the Center Web site (www.sri-rtp.com) or through the link on the ETV Program Web site (www.epa.gov/etv).

VERIFICATION OF PERFORMANCE

Leak Tightness and Gas Recovery Performance:

- SAS Leak Tightness: The entire SAS assembly was found to be leak tight with the exception of the ECGs. Based on 12 individual measurement samples, a total leak rate of 0 to 5.7 (± 0.6 to 5.4) scfm methane (CH_4) was measured at the three glands. The lowest leak rate was measured when the SAS was operating at design pressures (less than 0 psig). Over the 3-week Phase I evaluation period, the SAS operated at these pressures for less than 20 percent of the time.

- Gas Recovery Potential: The SAS recovered from 3.7 to 11.6 scfm gas, and injected it into the engine fuel line. The average recovery rate for the Phase I test was 7.2 ± 0.22 scfm gas. This equated to an average leak capture efficiency of 70 ± 10 percent. (Leak capture efficiencies ranged from 43 to 100 percent.)

- Methane Emission Reduction Potential: It was speculated that installation of the glands on the low-pressure region established in the ECGs has the potential to increase or decrease uncontrolled rod emissions. Under these conditions, the volume of gas recovered may be different than what would be emitted if the SAS was not installed (i.e., net methane emission reduction would be different than the total gas recovered). The Center was unable to conclusively determine if the SAS causes perturbations in the rod emission rates. This was because of the unscheduled failure and replacement of two rods after the SAS was installed; consequently, reliable emission estimates for the new rods could not be obtained prior to the Phase I testing. The Center will collect additional verification data in the Phase II test, and provide conclusions on the methane emissions reduction potential in the final report.

Installation and Operational Observations:

- Labor Requirements: The fabrication, installation, and high pressure testing of the SAS (ECGs, jets, Eductor/Compressor, valves, regulators, low and high pressure piping, and miscellaneous equipment) required approximately 300 labor hours. An additional 200 labor hours were required to install electrical components and instrumentation (i.e., one oxygen, two pressure, and two flow sensors/transmitters).

- Optimum Performance: The maximum gas recovery rates and highest leak capture efficiency was achieved when the SAS was operating at design conditions (i.e., gland suction pressures were negative). The SAS was unable to maintain design operational pressures when routine fluctuations in engine load requirements caused the fuel header pressures to increase. The Eductor/Compressor nozzle selected for the test site was unable to accommodate these normal operating conditions, and resulted in leaks at the glands as the SAS piping was pressurized.

- For natural gas compressor station application, the Center has identified three areas in the SAS design which may require modifications. First, the SAS must be capable of accommodating fluctuations in the fuel header static pressures which result from routine engine operation. The Eductor/Compressor system requires a nozzle with sufficient discharge pressure to withstand piping head loss so that it is able to recompress the captured gas under a full range of differential pressure encountered at the facility. Second, the tertiary seal must contain additional, and longer, fasteners to accommodate significant vibrations typically encountered at transmission station compressors. Third, the system must accommodate the removal of oil and other impurities that are typically found in captured gas. According to A&A ESI, there are no additional costs associated with supplying the SAS with a modified Eductor/Compressor nozzle and longer tertiary seal fasteners. All future systems are expected to contain these and other modifications.

Initial Technology Costs:

- Net Initial Costs: The capital cost for the SAS system, including mechanical equipment, piping, and electrical and instrumentation components, is estimated to be $30,933. Based on contractor logs, the net labor cost for SAS installation is $11,841. The total installed cost is $42,774. This includes costs associated with electrical and instrumentation components ($12,822), which can be offered as optional equipment.

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